

## **AMENDMENT**

### **Amendments to the Specification:**

**Please insert the following new paragraphs starting at line 17 of page 3:**

#### **SUMMARY**

Methods and systems are described for allocating network resources of a distributed virtual system to support managed, network-based services. According to one embodiment, a virtual router (VR)-based switch having multiple processing elements is provided that is configured for operation at an Internet point-of-presence (POP) of a service provider. A network operating system (NOS) is provided on each of the processing elements. The resources of the VR-based switch are segmented between at least a first subscriber of the service provider and a second subscriber of the service provider by associating a first set of VRs with the first subscriber, associating a second set of VRs with the second subscriber, mapping the first set of VRs onto a first set of the processing elements, mapping the second set of VRs onto a second set of the processing elements. Then, a first and second set of customized services are configured, each including two or more of firewalling, virtual private networking, encryption, traffic shaping, routing and network address translation (NAT), to be provided by the VR-based switch on behalf of the first and second subscriber, respectively. The first set of customized services is configured by allocating a first service object group within the first set of VRs. The first service object group includes a service object corresponding to each service of the first set of customized services and each service object of the first service object group can be dynamically distributed by the NOS to customized processors of the first set of processing elements to achieve desired computational support. The second set of customized services is configured by allocating a second service object group within the second set of VRs. The second service object group includes a service object corresponding to

each service of the second set of customized services and each service object of the second service object group can be dynamically distributed by the NOS to customized processors of the second set of processing elements to achieve desired computational support.

Other features of embodiments of the present invention will be apparent from the accompanying drawings and from the detailed description that follows.

### BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements and in which:

FIG. 1 is a block diagram illustrating an IP Service Delivery Platform in accordance with an embodiment of the present invention.

FIG. 2 conceptually illustrates a POP access infrastructure in accordance with a network-based managed firewall service model of an embodiment of the present invention.

FIG. 3 is a block diagram illustrating various services and functional units of an IPNOS in accordance with an embodiment of the present invention.

FIG. 4. conceptually illustrates interactions among various Object Manager layers in accordance with an embodiment of the present invention.

FIG. 5 conceptually illustrates an exemplary mapping of virtual routers onto processor elements.

FIG. 6 conceptually illustrates segmentation of a switch across a number of different subscribers in accordance with an embodiment of the present invention.

FIG. 7 is a block diagram illustrating two sub-layers of the network layer of the protocol stack in accordance with an embodiment of the present invention.

FIG. 8 conceptually illustrates inter-module transfers during firewall flow processing in accordance with an embodiment of the present invention.

FIG. 9 illustrates packet fragmentation and header content in accordance with an embodiment of the present invention.

FIGS. 10, 11, 12 and 13 conceptually illustrate various forward and reverse flow scenarios in accordance with an embodiment of the present invention.

FIG. 14 conceptually illustrates multi-point-to-point (MP-P) operation in accordance with an embodiment of the present invention.

**Please amend the paragraph starting at line 22 of page 10 as follows:**

The way that virtual routers map on processor elements can be understood in the context of Figure [[4]] 5. Figure [[4]] 5 shows a blade 28 having four processor elements (PEs) 30. Each processor element 30 includes a CPU and memory. In addition, each PE 30 is connected to the other PEs 30 and to the rest of switch 12 through connection fabric 32. In the embodiment shown in Figure [[4]] 5, two virtual routers 34 are mapped on blade 28. It should be noted that, in one embodiment, more than one virtual router can be mapped to a single PE 30, and vice versa. Blade 28 can, therefore, be a shared resource among two or more subscribers.

**Please amend the paragraph starting at line 31 of page 13 as follows:**

When shortcuts are created, an Object Channel termination will receive traffic from multiple Object Channel sources. ~~That is, we need~~ Consequently, according

to one embodiment, a multi-point-to-point (MP-P) Object Channel is used in the Flow Topology. The PRD for MP-P describes the proposed implementation in detail.

**Please amend the paragraph starting at line 38 of page 13 as follows:**

Both ends of a P-P ~~[[uses]]~~ use the initialization function obj\_init\_channel(). For MP-P, there will be 2 separate initialization ~~function~~ functions. For MP-P transmit, the initialization function is obj\_mpp\_tx\_init\_channel().~~[[.]]~~ For MP-P receive, the initialization function is obj\_mpp\_rx\_init\_channel(). ~~(Please refer to the PRD for actual function names).~~ There is also an anonymous mpp\_send() function that can be used (and which is bound to the channel end point by obj\_mpp\_tx\_init\_channel() to send anonymously to ~~[[an]]~~ a channel end point without using the Object Channel abstraction.

**Please amend the Abstract as follows:**

~~A virtual routing system, including a virtual router operating across one or more processing elements.~~ Methods and systems for allocating network resources are provided. According to one embodiment, a VR-based switch is configured for operation at a POP of a service provider. A NOS is provided on each processing element of the switch. Resources of the switch are segmented among multiple subscribers by associating sets of VRs with a first and second subscriber, mapping the sets of VRs onto sets of the processing elements, and configuring a first and second set of customized services, each including two or more of firewalling, virtual private networking, encryption, traffic shaping, routing and NAT, to be provided by the switch on behalf of the first and second subscribers, respectively, by allocating first and second service object groups within sets of VRs. Each service object can be dynamically distributed by the NOS to customized processors of the first or second set of processing elements to achieve desired computational support.